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Eastern Bering Sea (BASIS) Coastal Research (August - October 2002) on Juvenile Salmon

by

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Abstract

An eastern Bering Sea research cruise was conducted by National Marine Fisheries Service scientists from the Auke Bay Laboratory, Ocean Carrying Capacity program during August - October 2002 to study early marine distribution, migration, and growth of juvenile salmon (*Oncorhynchus* spp) salmon on the eastern Bering Sea shelf. A total of 10,629 salmon were captured including juvenile pink (*O. gorbuscha*; 5.9%), chum (*O. keta*; 43.4%), sockeye (*O. nerka*; 42.6%), coho (*O. kisutch*; 3.8%), and chinook (*O. tshawytscha*; 3.0%) salmon; less than 2% of the catch consisted of immature and mature chum, sockeye, and chinook salmon. Juvenile pink salmon were mainly distributed offshore between 60ºN to 63ºN. Juvenile chum salmon were widely distributed north of 58ºN, with the largest catches occurring along the 168ºW transect and between 60ºN to 63ºN east of 169ºW. Juvenile sockeye salmon were distributed south of 59ºN, with the largest catches occurring north of 57ºN along the 165ºW transect. Juvenile coho and chinook salmon were distributed nearshore along transects north of 58ºN. Juvenile pink, chum, sockeye, and chinook salmon were smallest within the area sampled during Leg 1 (southeastern Bering Sea; Bristol Bay) and largest within the area sampled during Leg 2 (northeastern Bering Sea). Juvenile sockeye salmon aged by the Alaska Department of Fish and Game's Mark, Tag, and Age Laboratory in Juneau, Alaska indicated that 69% were age 1.0 and 31% were age 2.0. Analyses of plankton, stomach contents, age, size, and growth data, and genetic stock identification, will be done for additional information on the growth and migration characteristics of juvenile salmon on the eastern Bering Sea shelf.

Introduction

Pacific salmon (*Oncorhynchus* spp.) runs to rivers emptying in the eastern Bering Sea have been inconsistent and at times very weak. Low returns of chinook (*O. tshawytscha*) and chum (*O. keta*) salmon to the Yukon River, Kuskokwim River, and Norton Sound areas of Alaska prompted the State of Alaska during 2000 to restrict commercial and subsistence fisheries and declare the region a fisheries disaster area. Weak salmon returns to these river systems follow several years of low sockeye (*O. nerka*) salmon returns to Bristol Bay, which was declared a fisheries disaster region during 1998 by both the State of Alaska and the U.S. Department of Commerce. Causes of the poor salmon returns to these river systems are not known, however, the regional-scale decline of these stocks indicates that the marine environment may play a critical role. Ocean conditions, particularly in the first few months after leaving freshwater, are known to significantly affect salmon survival (Holtby et al. 1990; Friedland et al. 1996; Beamish and Mahnken 2001). Mechanisms affecting marine survival of the eastern Bering Sea salmon stocks are unknown, principally due to the lack of marine life history information on salmon. In an effort to improve our understanding of the marine life-history stage of salmon in the Bering Sea, the North Pacific Anadromous Fish Commission (NPAFC) initiated a proposal for an

internationally coordinated research program on salmon in the Bering Sea called the Bering-Aleutian Salmon International Survey (BASIS) (NPAFC 2001).

As part of BASIS, scientists from the National Marine Fisheries Service (NMFS), Ocean Carrying Capacity (OCC) program conducted a fall survey on the eastern Bering Sea shelf to provide key ecological data for eastern Bering Sea salmon stocks during their juvenile life-history stage. The goal of the OCC/BASIS salmon research cruise was to understand mechanisms underlying the effects of environment on distribution, migration, and growth of juvenile salmon on the eastern Bering Sea shelf. Primary objectives of BASIS include: 1) to determine the extent of offshore migrations of juvenile salmon from rivers draining into the eastern Bering Sea, 2) to describe the physical environment of the eastern and northeastern Bering Sea shelf occupied by juvenile salmon, and 3) to collect biological information on other ecologically important species. Summaries of previous Bering Sea juvenile salmon research cruises can be found in Farley et al. (1999, 2000, 2001).

Methods

The OCC survey of the eastern Bering Sea was conducted during fall 2002 (August 17 – October 13). The cruise itinerary and participating scientists are listed in tables 1 and 2. Transects sampled during the survey were along longitudinal (161ºW to 168ºW) and latitudinal lines (60ºN to 65ºN; Figure 1). Sampling stations and locations along each transect are listed in Table 3.

The survey was conducted aboard the contracted fishing vessel (F/V) *Sea Storm* (38 m long). Fish samples were collected using two midwater rope trawls, models 400/580 and 300, made by Cantrawl Pacific Limited[1] of Richmond, B.C. Stations in relatively deeper waters along the 162ºW to 166ºW transects were sampled using a midwater trawl model 400/580; stations in relatively shallow waters along 167ºW, 168ºW, and latitudinal transects north of 60ºN were sampled using a midwater trawl model 300. Both nets are 198 m long, have hexagonal mesh in wings and body, and a 1.2-cm mesh liner in the codend. The 400/580 and 300 rope trawls were towed at 3.5 to 5 kts, at or near the surface, and had typical spreads of 41 m horizontally and 14 m vertically and 56 m horizontally and 12 m vertically, respectively. All tows lasted 30 minutes and covered 2.8 to 4.6 km. All sampling was done during daylight hours.

Salmon and other fishes were sorted by species and counted. Standard biological measurements including fork length, body weight, and sex were recorded. Scale samples (to document age and growth) from the preferred area (Clutter and Whitesel 1956) were taken from subsamples of all salmon species. Juvenile sockeye and chum salmon were frozen whole at 0ºC for genetic analyses. Prevalence and intensity of sea lice (*Lepeophtheirus salmonis*) infection on juvenile pink (*O. gorbuscha*) salmon was also examined during the survey (see

[1] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Trudel et al. 2002 for details). Otoliths from immature and maturing chum salmon were collected to document distribution and migration of hatchery salmon whose otoliths were thermally marked during incubation. Tissues from immature and maturing chum salmon were also collected (frozen at 0ºC) to document distribution of Pacific Rim stocks within the survey area. All other fish species were counted, and biological measurements including length and body weight were taken from subsamples of each species.

Oceanographic data were collected at each trawl station immediately prior to each trawl haul. Profiles of salinity and temperature from surface to near bottom depths were collected using a Sea-Bird SBE 19 Seacat profiler[2]. Plankton samples were collected using 60-cm diameter bongo samplers fitted with 505- and 333-µm mesh nets. The bongo nets were towed obliquely from near surface to approximately 10 m from the bottom; the estimated depth of each bongo tow was calculated by wire angle and length of wire. The volume of water filtered by each net was estimated by flow meters, and the plankton samples were preserved in 10% formalin.

Results and Discussion

During the survey, 152 trawl stations were sampled beginning at the southern end of 161ºW longitude and ending on the western end of 65ºN longitude (Figure 1; Table 3). A total of 10,629 salmon were captured (Table 4) including juvenile pink (5.9%), chum (43.4%), sockeye (42.6%), coho (*O. kisutch*; 3.8%), and chinook (3.0%) salmon; less than 2% of the catch consisted of immature and mature chum, sockeye, and chinook salmon. Other marine fish species captured during the survey include (see Table 5) walleye pollock (*Theragra chalcogramma*), crested sculpin (*Blepsias bilobus*), sturgeon poacher (*Podothecus acipenserinus*), Pacific herring (*Clupea pallasi*), Bering wolffish (*Anarhichas orientalis*), Pacific sandfish (*Trichodon trichodon*), capelin (*Mallotus villosus*), Pacific cod (*Gadus macrocephalus*), prowfish (*Zaprora silenus*), Pacific sandlance (*Ammodytes hexapterus*), northern rock sole (*Lepidopsetta peracuata*), lamprey (Petromyzontidae), sablefish (*Anoplopoma fimbria*), Atka mackerel (*Pleurogrammus monopterygius*), starry flounder (*Platichthys stellatus*), rainbow smelt (*Osmerus mordax*), rock greenling (*Hexagrammos lagocephalus*), salmon shark (*Lamna ditropis*), and saffron cod (*Eleginus gracilis*).

The distribution of juvenile salmon within the survey varied depending on species (Figures 2 A-E). Juvenile pink salmon were mainly distributed offshore along the 60ºN to 63ºN transects. Juvenile chum salmon were widely distributed along transects north of 58ºN, with the largest catches occurring along the 168ºW transect and along the 60ºN to 63ºN transects east of 169ºW. Juvenile sockeye salmon were distributed along transects south of 59ºN, with the largest catches occurring north of 57ºN along the 165ºW transect. Juvenile coho and chinook salmon were distributed nearshore along transects north of 58ºN.

[2] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Lengths and weights of juvenile salmon captured during the survey varied depending on the area of the eastern Bering Sea shelf sampled (Table 6). Juvenile pink, chum, sockeye, and chinook salmon were smallest within the area sampled during Leg 1 (southeastern Bering Sea; Bristol Bay) and largest within the area sampled during Leg 2 (northeastern Bering Sea). Juvenile sockeye salmon aged by the Alaska Department of Fish and Game's Mark, Tag, and Age Laboratory in Juneau, Alaska indicated that 69% were age 1.0 and 31% were age 2.0.

Acknowledgements

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Table 1. Cruise itinerary for the NMFS OCC/BASIS August 17 – October 13, 2002 eastern Bering Sea research cruise.

Date	Location/Activity
Leg 1	
17-Aug	Scientists arrive in Dutch Harbor, AK
18-Aug	Load scientists and gear
19-Aug	Leave Dutch Harbor, enroute northern end of 161°W (340 nmi)
20-Aug	Enroute 161°W; Begin sampling 161°W (south)
21-Aug	Continue sampling 161°W (south)
22-Aug	Continue sampling 161°W (south)
23-Aug	Continue sampling 161°W (south); enroute 162°W
24-Aug	Begin sampling 162°W (north)
25-Aug	Continue sampling 162°W (north)
26-Aug	Continue sampling 162°W (north); enroute 163°W
27-Aug	Begin sampling 163°W (south)
28-Aug	Continue sampling 163°W (south)
29-Aug	Continue sampling 163°W (south)
30-Aug	Continue sampling 163°W (south); enroute 164°W
31-Aug	Begin sampling 164°W (north)
1-Sept	Continue sampling 164°W (north)
2-Sept	Continue sampling 164°W (north)
3-Sept	Continue sampling 164°W (north); enroute 165°W
4-Sept	Begin sampling 165°W (south)
5-Sept	Continue sampling 165°W (south)
6-Sept	Continue sampling 165°W (south)
7-Sept	Continue sampling 165°W (south)
8-Sept	Continue sampling 165°W (south); enroute Dutch Harbor (65 nmi)
9-Sept	Unload Leg 1 scientists and samples; load Leg 2 scientists
Leg 2	
10-Sept	Leave Dutch Harbor, enroute southern end 166°W
11-Sept	Begin sampling 166°W (north)
12-Sept	Continue sampling 166°W (north)
13-Sept	Continue sampling 166°W (north)
14-Sept	Continue sampling 166°W (north); enroute 167°W
15-Sept	Begin sampling 167°W (south)
16-Sept	Continue sampling 167°W (south); enroute 168°W
17-Sept	Begin sampling 168°W (north)
18-Sept	Continue sampling 168°W (north); enroute western end of 60°N

Table 1 (Cont'd). Cruise itinerary for the NMFS OCC/BASIS August 17 – October 13, 2002 eastern Bering Sea research cruise.

Date	Location/Activity
Leg 2 (Cont'd)	
19-Sept	Begin sampling 60°N (west)
20-Sept	Continue sampling 60°N (west); enroute eastern end of 61°N (150 nmi)
21-Sept	Begin sampling 61°N (east)
22-Sept	Continue sampling 61°N (east)
23-Sept	Continue sampling 61°N (east); enroute western end of 62°N
24-Sept	Begin sampling 62°N (west)
25-Sept	Continue sampling 62°N (west)
26-Sept	Continue sampling 62°N (west); enroute Nome (160 nmi)
27-Sept	Arrive Nome; unload Leg 2 scientists and gear; load Leg 3 scientists
Leg 3	
28-Sept	Enroute 64°N (Norton Sound stations)
29-Sept	Begin sampling 64°N (Norton Sound stations); enroute 63°N
30-Sept	Begin sampling 63°N (west)
1-Oct	Continue sampling 63°N (west)
2-Oct	Continue sampling 63°N (west)
3-Oct	Continue sampling 63°N (west); enroute 64°N (eastern end)
4-Oct	Begin sampling 64°N (east)
5-Oct	Continue sampling 64°N (east)
6-Oct	Continue sampling 64°N (east); enroute 65°N (western end)
7-Oct	Begin sampling 65°N (east)
8-Oct	Continue sampling 65°N (east); enroute Dutch Harbor
9-Oct	Enroute Dutch Harbor
10-Oct	Enroute Dutch Harbor
11-Oct	Arrive Dutch Harbor; begin unloading gear
12-Oct	Unload Leg 3 scientists and samples; end cruise.
13-Oct	Scientists depart Dutch Harbor.

Table 2. Participating Scientists during the August 17 – October 13, 2002 OCC/BASIS juvenile salmon survey in the coastal waters of the eastern Bering Sea.

	Scientists	Affiliation
Leg 1 (Aug 17 – Sept 9)		
FPC	Ed Farley	NMFS/ABL
	Angela Middleton	NMFS/ABL
	John Pohl	NMFS/ABL
	Danielle McCallum	NWO, Inc.
Leg 2 (Sept 10 – Sept 27)		
FPC	Bruce Wing	NMFS/ABL
	Lee Hulbert	NMFS/ABL
	Jamal Moss	UW
	Edward Parks	YRDFA
	Marc Trudel	DFO
Leg 3 (Sept 28 – Oct 13)		
FPC	Ed Farley	NMFS/ABL
	Angela Middleton	NMFS/ABL
	Ted Hamilton	YRDFA
	Cindi Lagoudakis	USFS

FPC	-	Field Party Chief
NMFS	-	National Marine Fisheries Service
ABL	-	Auke Bay Laboratory
NPAFC	-	North Pacific Anadromous Fish Commission
DFO	-	Department of Fisheries and Oceans, Canada
YRDFA	-	Yukon River Drainage Fisheries Association
UW	-	University of Washington
NWO	-	Northwest Observers
USFS	-	United States Forest Service

Table 3. Haul information for the August 17 - October 13, 2002 OCC/BASIS juvenile salmon survey in the eastern Bering Sea.

Date	Transect	Haul ID	Lat °N	Lon °W	Course (degree)	Start Time	Speed (knots)	Net Opening Vertical (m)	Net Opening Horizontal (m)	Warp (m)	SST (°C)
8/20	161W	1	57.44	161.01	10	18:14	3.9	15	37	329	12.2
8/21	161W	2	57.30	161.01	56	7:53	3.9	13	37	329	12.2
8/21	161W	3	57.15	161.00	39	11:28	4.2	14	37	329	11.5
8/21	161W	4	56.60	161.01	44	14:50	3.9	14	40	329	11.3
8/21	161W	5	56.45	161.01	124	18:05	4.1	15	37	329	11.9
8/22	161W	6	56.30	161.01	104	7:52	3.5	14	37	329	12.1
8/22	161W	7	56.11	161.01	115	12:28	3.9	10	42	329	9.8
8/22	162W	8	55.56	162.03	128	18:46	4.6	12	42	329	10.3
8/23	162W	9	56.00	162.00	113	8:10	4.5	13	44	338	10.6
8/23	162W	10	56.15	162.01	120	13:13	4	12	42	338	11.4
8/23	162W	11	56.31	162.02	114	17:34	4.5	9	42	329	11.4
8/24	162W	12	56.46	162.01	124	7:56	3.8	16	42	329	10.1
8/24	162W	13	57.00	162.01	129	11:43	4.2	14	40	338	10.8
8/24	162W	14	57.14	161.60	3	15:08	3.9	14	40	335	10.4
8/24	162W	15	57.29	162.00	14	18:01	3.9	12	40	329	10.7
8/25	162W	16	57.44	162.00	15	7:48	4.2	15	40	331	11.9
8/25	162W	17	57.59	162.00	11	10:55	4.4	14	40	329	10.4
8/25	162W	18	58.14	162.00	2	13:52	3.8	14	42	335	9.3
8/25	162W	19	58.29	162.00	0	16:48	4	12	40	329	12.3
8/26	163W	20	58.31	163.01	147	7:42	3.3	16	44	329	11.2
8/26	163W	21	58.16	163.01	148	10:43	3.2	15	41	329	10.2
8/26	163W	22	58.00	163.00	171	13:43	4.3	16	41	329	9.7
8/26	163W	23	57.46	162.60	188	16:35	4.4	16	42	329	11.6
8/26	163W	24	57.30	162.60	176	19:44	4.2	15	37	335	12.1
8/27	163W	25	57.16	163.00	172	7:43	3.9	16	40	329	11.8
8/27	163W	26	57.01	163.01	146	10:53	3.9	13	29	335	11.3
8/27	163W	27	56.46	163.01	157	14:02	3.6	14	37	338	11.8
8/27	163W	28	56.30	163.00	137	17:16	4	14	38	338	11.9
8/27	163W	29	56.16	163.01	140	20:11	3.8	17	40	329	12.1
8/28	163W	30	56.01	163.01	130	7:54	3.8	13	40	338	11.7
8/28	163W	31	55.46	163.01	170	11:00	3.7	16	43	338	11.2
8/28	163W	32	55.31	162.60	188	13:52	3.9	16	42	338	10.9
8/28	163W	33	55.22	163.01	27	15:44	4.3	13	39	338	10.7
8/29	164W	34	55.16	163.59	193	8:13	3.9	14	34	338	9.9
8/29	164W	35	55.31	163.58	219	12:20	3.7	16	43	335	10.5
8/29	164W	36	55.46	163.60	195	15:49	4	15	42	338	11.0

Table 3 Cont'd. Haul information for the August 17 - October 13, 2002 OCC/BASIS juvenile salmon survey in the eastern Bering Sea.

								Net Opening			
Date	Transect	Haul ID	Lat °N	Lon °W	Course (degree)	Start Time	Speed (knots)	Vertical (m)	Horizontal (m)	Warp (m)	SST (°C)
8/29	164W	37	56.02	163.60	182	19:33	4.3	12	42	335	11.4
8/30	164W	38	56.16	164.01	130	8:13	4	14	43	329	11.5
8/30	164W	39	56.31	164.01	151	11:50	4.2	14	43	331	11.4
8/30	164W	40	56.46	164.01	157	15:14	4.2	16	42	337	11.8
8/30	164W	41	57.01	164.01	160	18:43	4.2	16	41	335	11.8
8/31	164W	42	57.15	164.02	98	8:00	3.5	16	37	333	11.4
8/31	164W	43	57.30	164.02	112	11:13	3.9	9	34	331	11.1
8/31	164W	44	57.45	164.02	116	14:27	4.2	13	38	333	11.2
8/31	164W	45	57.59	164.00	359	17:20	3.8	14	37	335	11.2
8/31	164W	46	58.15	164.02	75	20:10	4.3	14	44	335	9.7
9/1	164W	47	58.29	164.02	59	7:59	3.5	16	42	329	11.3
9/1	164W	48	58.46	164.01	124	10:54	3.6	14	41	329	10.8
9/1	164W	49	59.01	164.01	130	13:48	3.9	14	42	331	11.7
9/1	165W	50	59.16	165.01	150	19:01	5.1	13	41	329	12.2
9/2	165W	51	59.01	165.01	133	7:38	3.9	13	45	329	11.1
9/2	165W	52	58.46	165.02	113	10:33	3.4	16	42	329	10.9
9/2	165W	53	58.31	165.00	167	13:19	3.9	15	41	333	10.9
9/2	165W	54	58.16	165.00	182	16:12	3.9	16	45	329	10.9
9/2	165W	55	57.60	164.58	299	18:59	3.5	14	41	329	11.5
9/3	165W	56	57.44	164.59	329	8:34	4.1	18	35	329	11.3
9/3	165W	57	57.29	164.59	330	16:22	4.1	17	39	329	10.9
9/4	165W	58	57.14	165.01	26	8:13	3.8	15	34	329	11.3
9/4	165W	59	56.59	165.01	53	12:01	3.6	16	43	329	11.1
9/4	165W	60	56.44	165.01	49	15:38	4.3	13	44	333	11.0
9/4	165W	61	56.29	165.00	5	19:26	4.4	13	44	329	-
9/5	165W	62	56.14	165.02	58	8:34	3.3	14	42	329	10.1
9/10	166W	63	54.30	166.02	90	12:06	4.2	13	55	265	8.3
9/10	166W	64	54.60	166.02	90	17:18	4.2	11	55	329	8.9
9/10	166W	65	55.30	166.01	106	21:19	5.1	9	55	329	8.9
9/11	166W	66	55.60	166.00	40	8:50	5	14	59	329	9.8
9/11	166W	67	56.29	166.03	346	13:25	4.5	14	55	329	10.2
9/13	166W	68	59.16	166.02	127	7:54	3.5	14	51	329	11.1
9/13	166W	69	59.01	166.02	126	10:55	3.8	11	53	329	10.7
9/13	166W	70	58.46	166.00	178	13:53	4	12	55	329	9.7
9/13	166W	71	58.31	165.59	226	16:45	4.4	13	55	329	9.4
9/13	166W	72	58.16	165.59	-	19:30	5.3	13	55	329	8.7

Table 3 Cont'd. Haul information for the August 17 - October 13, 2002 OCC/BASIS juvenile salmon survey in the eastern Bering Sea.

								Net Opening			
Date	Transect	Haul ID	Lat °N	Lon °W	Course (degree)	Start Time	Speed (knots)	Vertical (m)	Horizontal (m)	Warp (m)	SST (°C)
9/14	166W	73	58.00	166.01	144	10:15	4.5	11	55	329	8.5
9/14	166W	74	57.31	166.01	138	14:15	4.5	13	55	329	9.2
9/14	166W	75	57.01	166.01	139	18:11	5.2	12	55	329	8.3
9/15	167W	76	57.44	167.01	45	8:24	3.9	11	55	329	8.3
9/15	167W	77	57.59	167.01	45	11:28	4.4	13	55	329	7.9
9/15	167W	78	58.15	167.01	46	14:25	5	13	55	329	8.3
9/15	167W	79	58.29	167.01	21	18:59	4	11	55	329	8.6
9/16	167W	80	58.44	166.59	335	8:50	4.4	13	55	329	8.8
9/16	167W	81	58.59	167.01	34	11:45	4.2	11	55	329	10.3
9/16	167W	82	59.14	167.00	27	14:35	5.1	13	55	329	10.5
9/16	167W	83	59.31	166.58	218	17:20	3.9	13	55	329	10.5
9/17	168W	84	60.01	167.60	192	8:35	4.5	12	55	329	10.1
9/17	168W	85	59.46	167.60	186	11:35	4.6	13	55	329	9.6
9/17	168W	86	59.31	168.00	-	14:28	4.3	13	55	329	8.9
9/17	168W	87	59.16	168.00	177	17:20	4	13	55	329	9.1
9/17	168W	88	59.01	168.00	180	20:13	5	13	55	329	8.9
9/18	168W	89	58.46	168.00	176	8:33	4.5	13	55	329	8.2
9/18	168W	90	58.31	168.00	176	11:20	4.7	12	55	329	8.1
9/18	168W	91	58.16	168.01	146	14:08	4	13	55	329	8.2
9/18	168W	92	57.59	167.59	323	17:14	4.9	12	55	329	9.1
9/19	60N	93	60.01	170.32	122	9:00	4.8	12	55	329	8.8
9/19	60N	94	60.00	170.03	107	13:24	4.4	13	55	329	7.8
9/19	60N	95	60.01	169.32	121	16:24	4.1	13	55	329	7.6
9/19	60N	96	60.01	169.01	142	19:14	4.5	13	55	329	8.3
9/19	60N	97	60.01	168.31	151	21:29	5.1	11	55	329	9.3
9/20	61N	98	61.00	166.57	273	8:42	3.5	13	55	329	8.7
9/20	61N	99	61.00	167.28	275	11:26	4.1	11	55	329	8.4
9/20	61N	100	61.00	167.59	272	14:02	5	13	55	329	8.4
9/20	61N	101	61.00	168.28	270	16:38	5	12	55	329	9.3
9/20	61N	102	61.00	168.57	268	19:14	4.4	12	55	329	8.3
9/21	61N	103	61.00	169.28	264	8:47	4.5	13	55	329	7.8
9/21	61N	104	61.00	169.58	258	11:33	4.3	13	55	329	7.7
9/21	61N	105	61.00	170.28	248	14:32	4.5	13	55	329	8.2
9/21	61N	106	61.01	170.58	239	17:11	4.5	13	55	329	8.1
9/21	61N	107	61.01	171.28	224	19:55	4.3	12	55	329	8.3
9/22	62N	108	62.00	169.58	240	8:51	4.5	13	55	329	7.3

Table 3 Cont'd. Haul information for the August 17 - October 13, 2002 OCC/BASIS juvenile salmon survey in the eastern Bering Sea.

Date	Transect	Haul ID	Lat °N	Lon °W	Course (degree)	Start Time	Speed (knots)	Net Opening Vertical (m)	Net Opening Horizontal (m)	Warp (m)	SST (°C)
9/22	62N	109	62.02	170.29	239	11:33	4.2	13	55	329	7.3
9/22	62N	110	62.01	170.58	233	14:27	4.5	13	55	329	7.4
9/22	62N	111	62.01	171.28	236	17:11	4.9	13	55	329	7.5
9/22	62N	112	62.00	171.58	246	19:54	4.6	13	55	329	7.3
9/23	62N	113	61.60	169.32	88	8:40	4.4	13	55	329	7.4
9/23	62N	114	61.60	169.02	90	11:17	4.7	13	55	329	7.4
9/23	62N	115	61.52	168.32	87	13:54	5.2	11	55	329	7.0
9/23	62N	116	61.60	168.03	90	16:23	4.5	13	55	329	7.6
9/23	62N	117	61.60	167.28	292	19:02	5	11	55	329	7.9
9/24	62N	118	61.59	166.60	0	9:01	4.5	13	55	329	7.7
9/28	65N	119	65.01	167.33	127	19:48	3.7	12	62	329	7.3
9/29	65N	120	65.00	167.57	259	8:46	4.8	13	55	329	6.1
9/29	65N	121	65.01	168.31	156	12:06	4.4	12	53	329	6.3
9/29	65N	122	65.01	169.01	165	15:00	4.3	13	57	329	3.7
9/29	65N	123	65.01	169.31	167	17:52	4.3	11	59	329	2.7
9/30	64N	124	64.00	172.02	92	8:53	5	11	62	329	7.2
9/30	64N	125	64.00	171.32	88	11:13	4.6	11	52	329	6.8
9/30	64N	126	64.00	171.01	87	13:43	4.7	11	57	329	6.2
9/30	64N	127	64.00	170.32	87	16:03	5.1	11	57	329	5.3
9/30	64N	128	64.00	170.01	90	18:23	5.5	11	57	329	5.8
10/1	64N	129	64.00	169.31	85	19:52	5	11	57	329	5.7
10/2	64N	130	64.00	169.02	90	8:42	4.8	12	56	329	6.1
10/2	64N	131	64.00	168.32	86	11:00	4.8	11	59	329	5.8
10/2	64N	132	64.00	168.01	93	13:27	4.4	11	55	329	5.3
10/2	64N	133	64.00	167.32	90	15:49	4.4	11	57	329	5.8
10/2	64N	134	64.00	167.02	90	18:12	4.6	12	58	329	6.6
10/3	64N	135	64.00	166.32	90	8:46	4.6	11	57	329	6.6
10/3	64N	136	64.00	166.02	87	11:12	3.8	11	60	329	6.3
10/3	64N	137	64.06	164.31	91	17:11	4.4	11	50	329	7.7
10/3	64N	138	64.06	163.59	270	19:30	4.8	11	55	329	7.8
10/4	63N	139	62.60	165.44	270	8:51	4.9	9	59	329	6.9
10/4	63N	140	63.00	165.58	270	10:39	4.6	12	59	329	7.1
10/4	63N	141	63.00	166.31	270	13:18	4.5	10	59	329	6.9
10/4	63N	142	63.00	166.59	270	15:39	4.8	11	59	329	7.3
10/4	63N	143	63.00	167.29	270	18:07	4.7	12	60	329	6.0
10/5	63N	144	63.00	167.59	240	9:03	4.5	11	57	329	5.6

Table 3 Cont'd. Haul information for the August 17 - October 13, 2002 OCC/BASIS juvenile salmon survey in the eastern Bering Sea.

Date	Transect	Haul ID	Lat °N	Lon °W	Course (degree)	Start Time	Speed (knots)	Net Opening Vertical (m)	Net Opening Horizontal (m)	Warp (m)	SST (°C)
10/5	63N	145	62.54	168.29	230	11:48	4.7	11	57	329	5.2
10/5	63N	146	62.51	168.59	225	14:32	5.2	12	55	329	4.3
10/5	63N	147	62.45	169.29	226	17:12	5	11	56	329	5.8
10/6	63N	148	63.00	170.28	270	9:23	4.5	11	54	329	4.7
10/6	63N	149	63.01	170.59	213	12:19	4.7	11	59	329	6.4
10/6	63N	150	63.01	171.29	203	14:55	4.8	11	57	329	6.6
10/6	63N	151	63.02	171.60	183	17:39	4.5	12	59	329	6.5
10/7	63N	152	63.01	172.30	178	9:31	4.2	11	56	329	6.5

Table 4. Catch per unit effort (CPUE) of juvenile (J), immature (I), and adult (A) salmon by the F/V *Sea Storm* in the eastern Bering Sea, August 17 - October 13, 2002. Dash (-) indicates no salmon caught.

Date	Haul	Pink		Chum			Sockeye			Coho		Chinook		
	ID	J	A	J	I	A	J	I	A	J	A	J	I	A
8/20	1	-	-	-	-	-	4	-	-	-	-	1	-	-
8/21	2	-	-	4	-	-	66	-	-	-	-	1	-	-
8/21	3	-	-	1	-	-	4	-	-	-	-	-	-	-
8/21	4	-	-	-	-	-	10	-	-	-	-	-	-	-
8/21	5	-	-	-	-	-	18	-	-	-	-	-	-	-
8/22	6	-	-	3	-	-	10	-	-	-	-	-	-	-
8/22	7	-	-	1	-	-	13	-	1	6	1	-	-	-
8/22	8	-	2	1	-	-	1	-	-	1	1	-	-	-
8/23	9	-	2	70	-	-	14	-	-	10	2	-	-	-
8/23	10	-	-	1	-	-	14	-	-	-	-	-	-	-
8/23	11	-	-	3	-	-	5	-	-	-	-	-	-	-
8/24	12	-	-	3	-	-	57	-	-	1	-	-	-	-
8/24	13	-	-	1	-	-	25	-	-	-	-	-	-	-
8/24	14	-	-	3	-	1	124	-	-	-	-	-	-	-
8/24	15	-	-	3	-	-	64	-	-	-	-	-	-	-
8/25	16	-	-	1	-	-	80	-	-	-	-	1	-	-
8/25	17	-	1	1	-	-	47	-	-	1	-	2	-	-
8/25	18	-	-	9	-	-	27	-	-	1	-	37	-	-
8/25	19	-	-	10	-	-	39	-	-	6	-	21	-	-
8/26	20	-	-	15	-	-	-	-	-	27	-	49	-	-
8/26	21	-	-	3	-	-	86	-	-	1	-	15	-	-
8/26	22	-	-	-	-	-	39	-	-	-	-	1	-	-
8/26	23	-	-	-	-	-	29	-	-	-	-	2	-	-
8/26	24	-	-	2	-	-	64	-	-	-	1	-	-	-
8/27	25	-	-	-	1	-	15	-	-	-	1	-	-	-
8/27	26	-	-	-	-	-	37	-	-	-	-	-	-	-
8/27	27	-	-	1	-	-	86	-	-	-	-	-	-	-
8/27	28	-	-	1	-	-	59	-	-	-	-	-	-	-
8/27	29	-	-	-	-	-	38	-	-	-	-	-	-	-
8/28	30	-	-	-	-	-	-	-	-	-	-	-	-	-
8/28	31	1	-	37	-	-	20	-	-	5	1	-	-	-
8/28	32	2	-	2	-	-	27	-	-	25	-	-	-	-
8/28	33	-	-	-	-	4	-	-	-	4	-	-	-	-
8/29	34	-	-	-	7	1	-	-	-	-	-	-	-	-
8/29	35	1	-	-	-	-	4	-	-	-	-	-	-	-
8/29	36	-	-	11	-	3	41	-	-	1	-	-	-	-

Table 4 Cont'd. Catch per unit effort (CPUE) of juvenile (J), immature (I), and adult (A) salmon by the F/V *Sea Storm* in the eastern Bering Sea, August 17 - October 13, 2002. Dash (-) indicates no salmon caught.

Date	Haul	Pink		Chum			Sockeye			Coho		Chinook		
	ID	J	A	J	I	A	J	I	A	J	A	J	I	A
8/29	37	-	-	1	-	-	3	-	-	-	-	-	-	-
8/30	38	-	-	3	-	-	39	-	-	1	-	-	-	-
8/30	39	-	-	-	-	-	8	-	-	-	-	-	-	-
8/30	40	-	-	1	-	-	43	-	-	1	-	-	-	-
8/30	41	-	-	3	-	-	40	-	-	1	-	-	-	-
8/31	42	-	-	-	-	-	5	-	-	1	-	-	-	-
8/31	43	-	-	-	-	-	24	-	-	1	-	-	-	-
8/31	44	-	-	1	-	-	35	-	-	1	-	-	-	-
8/31	45	-	-	2	-	-	50	-	-	1	-	1	-	-
8/31	46	-	-	-	-	-	15	-	-	-	-	-	-	-
9/1	47	-	-	2	-	-	-	-	-	3	-	-	-	-
9/1	48	-	-	28	-	1	17	-	-	3	-	7	-	-
9/1	49	-	-	9	-	-	2	-	-	17	-	7	-	-
9/1	50	-	-	9	-	-	-	-	-	39	-	4	-	-
9/2	51	-	-	44	-	-	3	-	-	32	-	8	-	-
9/2	52	-	-	38	-	-	30	-	-	2	-	8	-	-
9/2	53	-	-	50	-	-	75	-	-	3	-	5	-	-
9/2	54	1	-	95	-	-	1200	-	-	53	-	7	-	-
9/2	55	-	-	-	-	-	222	-	-	-	-	-	-	1
9/3	56	-	-	-	-	1	167	-	-	1	-	-	-	-
9/3	57	-	-	1	1	-	478	-	-	-	-	-	-	-
9/4	58	-	-	-	-	-	57	-	-	-	-	-	-	-
9/4	59	-	-	-	-	-	66	-	-	-	-	-	-	-
9/4	60	-	-	-	-	-	59	1	-	-	-	-	-	-
9/4	61	1	-	-	1	-	95	-	1	-	-	-	-	-
9/5	62	-	-	-	-	-	91	-	-	-	-	-	1	-
9/10	63	6	-	-	28	-	-	1	-	-	-	-	-	-
9/10	64	3	-	1	6	-	-	-	-	-	-	-	1	-
9/10	65	-	-	-	21	-	-	-	-	-	-	-	1	-
9/11	66	-	-	-	4	-	-	2	-	-	-	-	-	-
9/11	67	-	-	-	-	-	113	-	-	-	-	-	-	-
9/13	68	-	-	20	-	-	-	-	-	19	-	-	-	-
9/13	69	-	-	16	-	-	-	-	-	11	-	3	-	-
9/13	70	-	-	82	-	-	3	-	-	1	-	2	-	-
9/13	71	-	-	21	-	-	10	-	-	1	-	4	-	-
9/13	72	-	-	16	-	-	6	-	-	-	-	-	-	-

Table 4 Cont'd. Catch per unit effort (CPUE) of juvenile (J), immature (I), and adult (A) salmon by the F/V *Sea Storm* in the eastern Bering Sea, August 17 - October 13, 2002. Dash (-) indicates no salmon caught.

Date	Haul	Pink		Chum			Sockeye			Coho		Chinook		
	ID	J	A	J	I	A	J	I	A	J	A	J	I	A
9/14	73	-	-	36	-	-	13	-	-	-	-	-	-	-
9/14	74	-	-	1	-	1	153	-	-	2	-	-	-	-
9/14	75	-	-	-	-	3	85	-	-	-	-	-	1	-
9/15	76	-	-	-	-	-	18	-	-	-	-	1	1	-
9/15	77	1	-	2	1	-	10	-	-	-	-	-	1	-
9/15	78	2	-	4	-	-	4	-	-	1	-	1	-	-
9/15	79	-	-	125	-	-	28	-	-	-	-	-	-	-
9/16	80	-	-	30	-	-	2	-	-	8	-	2	-	-
9/16	81	1	-	98	-	-	2	-	-	48	-	1	-	-
9/16	82	1	-	43	-	-	1	-	-	11	-	2	-	-
9/16	83	-	-	54	-	-	1	-	-	12	-	3	-	-
9/17	84	-	-	18	-	-	2	-	-	-	-	5	-	-
9/17	85	4	-	92	-	-	1	-	-	16	-	3	-	-
9/17	86	2	-	81	-	-	-	-	-	6	-	2	-	-
9/17	87	4	-	240	1	-	1	-	-	3	-	1	-	-
9/17	88	3	-	488	-	-	2	-	-	-	-	-	-	-
9/18	89	-	-	82	-	-	6	-	-	-	-	2	-	-
9/18	90	-	-	2	-	-	6	-	-	-	-	-	-	-
9/18	91	4	-	15	-	-	23	-	-	1	-	-	-	-
9/18	92	3	-	2	3	1	72	-	-	1	-	-	-	-
9/19	93	2	-	3	-	-	-	-	-	-	-	-	-	-
9/19	94	43	-	11	-	1	20	-	-	-	-	-	-	-
9/19	95	12	-	13	-	-	13	-	-	-	-	-	-	-
9/19	96	28	-	104	-	-	6	-	-	-	-	1	-	-
9/19	97	6	-	109	-	-	-	-	-	1	-	3	1	-
9/20	98	-	-	1	-	-	-	-	-	-	-	6	-	-
9/20	99	4	-	151	-	-	-	-	-	-	-	2	-	-
9/20	100	9	-	50	-	-	-	-	-	-	-	4	-	-
9/20	101	34	-	370	-	-	-	-	-	5	-	10	-	-
9/20	102	35	-	143	-	-	-	-	-	1	-	8	-	-
9/21	103	2	-	38	-	-	-	-	-	-	-	5	-	-
9/21	104	18	-	58	-	-	-	-	-	-	-	-	1	-
9/21	105	8	-	20	-	-	-	-	-	-	-	-	-	-
9/21	106	30	-	12	-	-	-	-	-	-	-	-	-	-
9/21	107	52	-	22	-	-	-	-	-	1	-	1	-	-
9/22	108	-	-	5	-	-	-	-	-	-	-	2	-	-

Table 4 Cont'd. Catch per unit effort (CPUE) of juvenile (J), immature (I), and adult (A) salmon by the F/V *Sea Storm* in the eastern Bering Sea, August 17 - October 13, 2002. Dash (-) indicates no salmon caught.

Date	Haul	Pink		Chum			Sockeye			Coho		Chinook		
	ID	J	A	J	I	A	J	I	A	J	A	J	I	A
9/22	109	2	-	22	-	-	-	-	-	-	-	-	-	-
9/22	110	33	-	195	-	-	6	-	-	-	-	-	3	-
9/22	111	199	-	100	-	-	1	-	-	-	-	1	-	-
9/22	112	19	-	20	-	-	-	-	-	-	-	3	1	-
9/23	113	-	-	-	-	-	-	-	-	-	-	-	-	-
9/23	114	10	-	19	-	1	-	-	-	-	-	2	-	-
9/23	115	21	-	89	-	-	2	-	-	-	-	3	-	-
9/23	116	2	-	92	-	-	-	-	-	2	-	6	-	-
9/23	117	-	-	164	-	-	-	-	-	3	-	2	-	-
9/24	118	-	-	-	-	-	-	-	-	3	-	2	-	-
9/28	119	-	-	-	-	-	-	-	-	-	-	2	1	-
9/29	120	-	-	-	-	-	-	-	-	-	-	-	-	-
9/29	121	2	-	14	-	-	-	-	-	-	-	-	-	-
9/29	122	1	-	2	-	-	-	-	-	-	-	-	-	-
9/29	123	-	-	1	-	-	-	-	-	-	-	-	-	-
9/30	124	-	-	-	-	-	1	-	-	-	-	-	-	-
9/30	125	2	-	8	-	-	2	-	-	-	-	-	-	-
9/30	126	-	-	-	-	-	-	-	-	-	-	1	-	-
9/30	127	1	-	4	-	-	-	-	-	-	-	-	-	-
9/30	128	-	-	-	-	-	-	-	-	-	-	-	-	-
10/1	129	-	-	3	-	1	-	-	-	-	-	-	-	-
10/2	130	-	-	-	-	-	-	-	-	-	-	-	-	-
10/2	131	7	-	23	-	-	2	-	-	-	-	-	-	-
10/2	132	-	-	-	-	-	1	-	-	-	-	-	1	-
10/2	133	-	-	17	-	-	-	-	-	-	-	-	-	-
10/2	134	-	-	-	-	-	-	-	-	-	-	-	-	-
10/3	135	-	-	-	-	-	-	-	-	-	-	-	-	-
10/3	136	-	-	-	-	-	-	-	-	-	-	-	-	-
10/3	137	-	-	11	-	-	-	-	-	-	-	18	-	-
10/3	138	-	-	4	-	-	-	-	-	-	1	13	-	-
10/4	139	-	-	-	-	-	-	-	-	-	-	5	-	-
10/4	140	-	-	6	-	-	-	-	-	-	-	9	-	-
10/4	141	7	-	280	-	-	-	-	-	-	-	-	-	-
10/4	142	-	-	208	-	-	-	-	-	-	-	2	-	-
10/4	143	-	-	43	-	-	-	-	-	-	-	1	-	-
10/5	144	1	-	1	-	-	-	-	-	-	-	1	-	-

Table 4 Cont'd. Catch per unit effort (CPUE) of juvenile (J), immature (I), and adult (A) salmon by the F/V *Sea Storm* in the eastern Bering Sea, August 17 - October 13, 2002. Dash (-) indicates no salmon caught.

Date	Haul	Pink		Chum			Sockeye			Coho		Chinook		
	ID	J	A	J	I	A	J	I	A	J	A	J	I	A
10/5	145	-	-	15	2	-	-	-	-	-	-	-	-	-
10/5	146	-	-	2	-	-	-	-	-	-	-	-	-	-
10/5	147	-	-	-	-	-	-	-	-	-	-	-	-	-
10/6	148	-	-	-	-	-	-	-	-	-	-	-	-	-
10/6	149	-	-	-	-	-	-	-	-	-	-	-	-	-
10/6	150	-	-	4	-	-	-	-	-	-	-	-	-	-
10/6	151	-	-	-	-	-	-	-	-	-	-	-	-	-
10/7	152	1	-	33	-	-	1	-	-	-	-	1	-	-

Table 5. Catch of marine fishes by the F/V Sea Storm in the eastern Bering Sea, August 17 - October 11, 2002. (Leg 1: August 17 - September 9; Leg 2: September 10 - September 28; Leg 3: September 29 - October 11.) Dash (-) indicates no marine fishes caught. Life history stages include young of the year (YOY) and adult (A).

Scientific Name	Life-history stage	Leg 1	Leg 2	Leg 3
Theragra chalcogramma	YOY	196,151	219,456	1,439
Theragra chalcogramma	A	27	10	5
Blepsias bilobus	A	115	32	1
Podothecus acipenserinus	A	14	-	1
Clupea pallasi	A	1,032	67,852	35,894
Anarhichas orientalis	Juvenile	9	1	-
Trichodon trichodon	A	8,906	35	-
Mallotus villosus	A	15	16	5,626
Gadus macrocephalus	YOY	9,593	3	2
Zaprora silenus	YOY	156	6	1
Ammodytes hexapterus	A	557	18	7,958
Lepidopsetta peracuata	A	6	2	-
Petromyzontidae	A	7	60	31
Anoplopoma fimbria	YOY	2	4	-
Pleurogrammus monopterygius	YOY	3	9	-
Platichthys stellatus	A	1	1	11
Osmerus mordax	A	-	6,375	3,629
Hexagrammos lagocephalus	YOY	-	17	-
Lamna ditropis	A	-	1	-
Eleginus gracilis	YOY	-	32	7
Eleginus gracilis	A	-	1	-

Table 6. Number sampled (*n*), length, and weight for juvenile pink, chum, sockeye, coho, and chinook salmon captured by the F/V *Sea Storm* during the OCC/BASIS cruise in the eastern Bering Sea, August 17 - October 13, 2002. (Leg 1: August 17 - September 10; Leg 2: September 11 - 28; Leg 3: September 29 - October 13.) Dash (-) indicates either no salmon caught or sample too small to summarize. Avg = Average; SD = Standard deviation.

	Leg 1					Leg 2					Leg 3				
		Length (mm)		Weight (g)			Length (mm)		Weight (g)			Length (mm)		Weight (g)	
Species	*n*	Avg	SD	Avg	SD	*n*	Avg	SD	Avg	SD	*n*	Avg	SD	Avg	SD
Pink	6	157.0	14.9	38.7	12.6	411	214.6	18.0	100.2	25.8	22	197.9	20.7	75.0	26.3
Chum	409	168.6	19.4	110.9	61.2	1,431	200.4	16.6	86.7	22.7	292	208.0	14.5	95.6	20.8
Sockeye															
Age 1.0	1,128	182.7	24.9	67.7	30.3	9	215.7	26.5	110.6	36.7	-	-	-	-	-
Age 2.0	476	204.2	35.8	100.4	48.4	37	246.4	17.0	164.0	32.6	-	-	-	-	-
Coho	115	279.4	27.8	295.3	89.5	165	274.7	55.5	289.0	136.7	-	-	-	-	-
Chinook	168	202.2	23.0	112.1	61.7	92	240.9	27.6	177.3	65.7	47	213.8	39.6	132.4	65.4

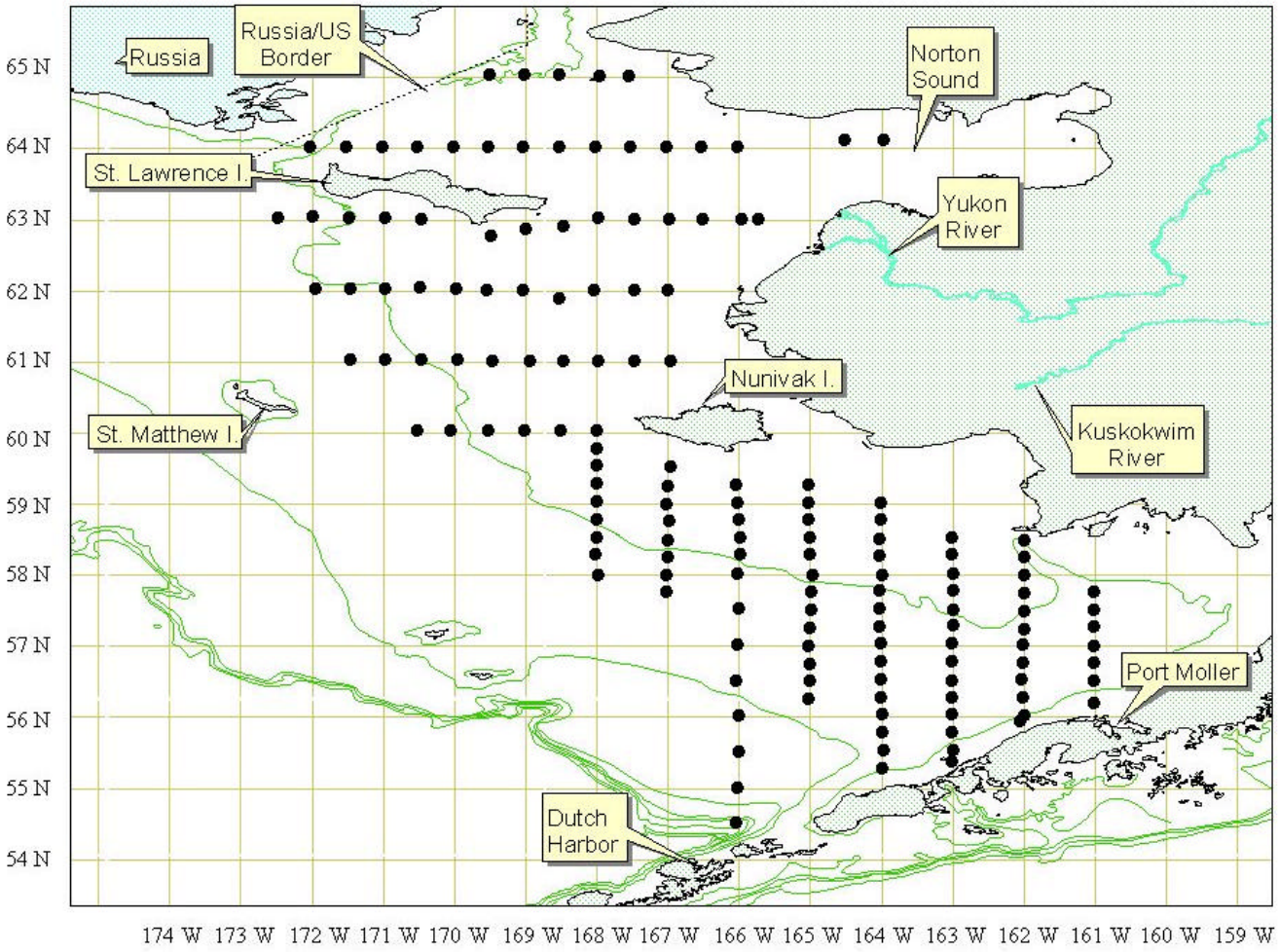

Figure 1. Stations (dots) sampled by the NMFS, OCC/BASIS cruise in the eastern Bering Sea, August 17 – October 13, 2002. Leg 1 stations include those along longitudinal transects 161°W to 165°W; Leg 2 stations include those along longitudinal transects 166°W to 167°W and along latitudinal transects 60°N to 62°N; Leg 3 stations include those along latitudinal transects 63°N to 65°N.

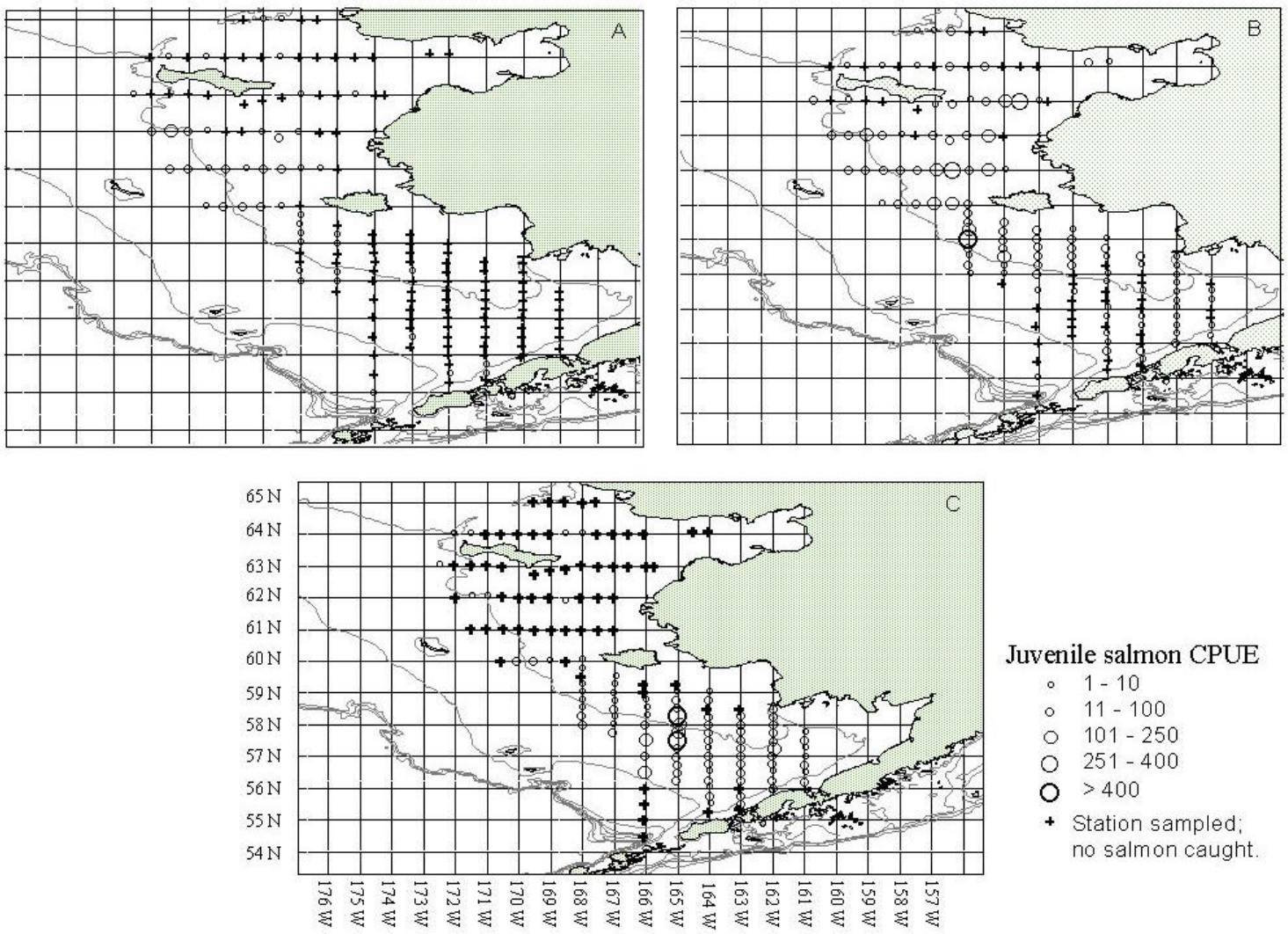

Figure 2. Distribution (shown by graduated symbol of catch per unit effort (CPUE) – see Table 4) of juvenile pink (A), chum (B), and sockeye (C) salmon captured by the F/V *Sea Storm* (August 17 – October 13, 2002) in the eastern Bering Sea. (+ indicates location sampled, but no juvenile salmon of a particular species were caught).

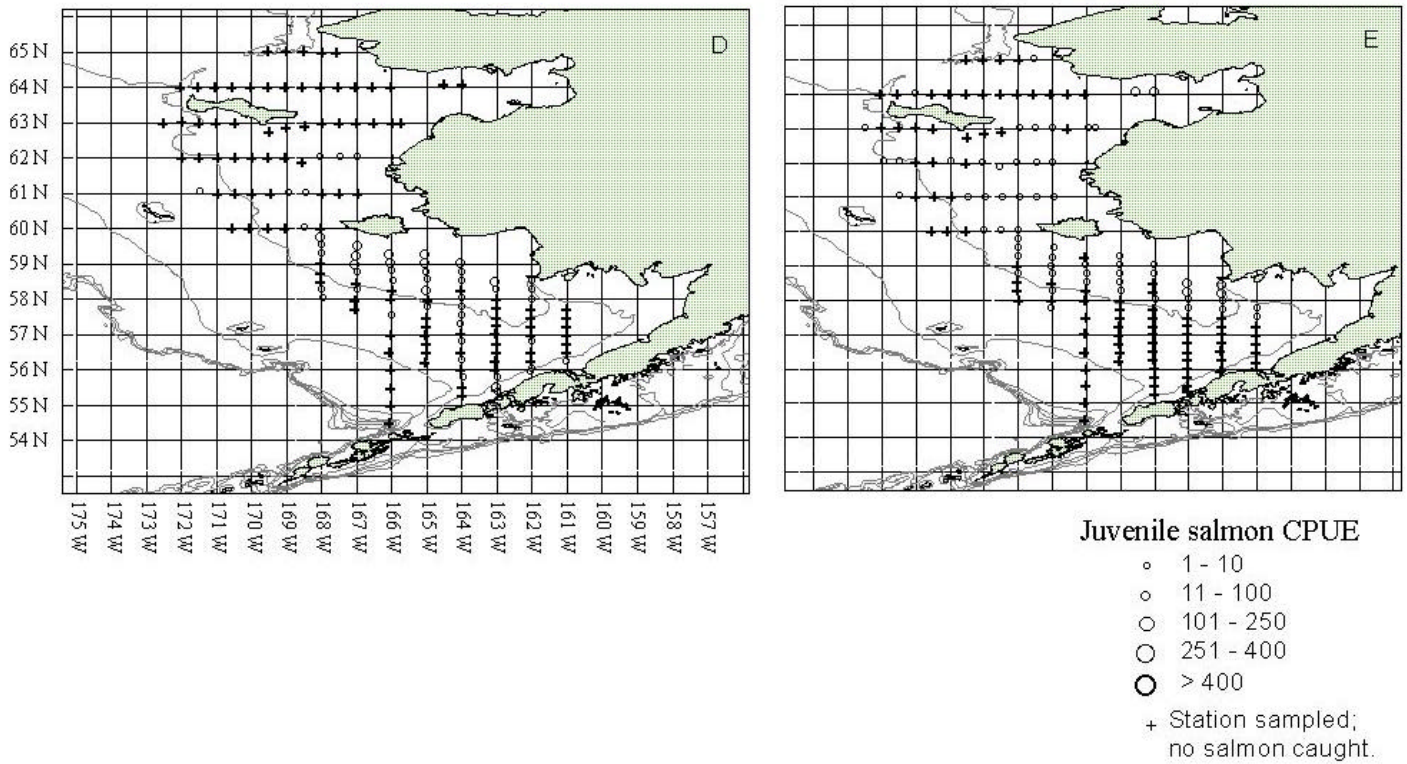

Figure 2 (Cont'd). Distribution (shown by graduated symbol of catch per unit effort (CPUE) – see Table 4) of juvenile Coho (D) and chinook (E) salmon captured by the F/V *Sea Storm* (August 17 – October 13, 2002) in the eastern Bering Sea. (+ indicates location sampled, but no juvenile salmon of a particular species were caught).